Human-Centred Learning Analytics

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Human-Centred Learning Analytics

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Abstract

The design of effective learning analytics (LA) extends beyond sound technical and pedagogical principles. If analytics are to be adopted and used successfully to support learning and teaching, their design process needs to take into account a range of human factors, including why and how they will be used. In this editorial, we introduce principles of human-centred design developed in other, related fields that can be adopted and adapted to support the development of human-centred learning analytics (HCLA). We draw on the papers in this special section, together with the wider literature, to define human-centred design in the field of LA and to identify the benefits and challenges that this approach offers. We conclude by suggesting that HCLA will enable the community to achieve more impact, more quickly, with tools that are fit for the purpose and a pleasure to use.

Notes for Practice

- The process of embedding innovative technology in authentic contexts is as much a human challenge — cognitive, social, organizational, political — as it is a technical challenge.
- Human-centredness has been identified in other fields as a characteristic of systems that have been carefully designed by identifying the critical stakeholders, their relationships, and the contexts in which those systems will function.
- This approach opens up new possibilities for companies and academia to work together to design effective learning analytics (LA).
- The papers in this special section provide a snapshot of how human-centred approaches are currently being applied to LA.
- Human-centred learning analytics (HCLA) addresses problems with implementation and take-up that are associated with other design approaches.
- Related work in other fields can be adopted and adapted for use with LA, but challenges specific to learning and teaching must be addressed.

Keywords

Human-centred design, participatory design, co-design, human-computer interaction.

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1. Introduction

Usability has revolutionized computing, providing an important basis for choosing between products in crowded markets. Consider the impact that Apple has had on our experience of personal computing and smartphones, through its integration of hardware, software, and the user interface, refined through extensive user testing. Digital infrastructure has evolved and pervaded our personal and working lives. Usability, interaction design, and user experience are no longer viewed simply in terms of an individual interacting efficiently with a software application to perform tasks. They are now seen in far richer, social, experiential terms. Where is the field of learning analytics (LA) on this design journey?

As the Society for Learning Analytics Research (SoLAR) and the Learning Analytics and Knowledge (LAK) conference approach their tenth anniversary, deep reflection on the many levels of human factors involved in the conception, design, deployment, and sustaining of LA systems is increasingly important. The educational marketplace is filled with products promoting learning dashboards. Some academic research prototypes have already matured into robust tools used by hundreds or thousands of students. However, the failure to transition from exciting concept demonstrators to embedded practical tools has long dogged educational technology (Scanlon et al., 2013), and there is no reason to suppose that LA will be spared this.

The success or failure of LA tools cannot be judged solely on technical criteria, but also by their adoption and effectiveness in different environments, including schools, universities, and workplaces. The complexity of embedding innovative technology in authentic contexts is as much a human challenge — cognitive, social, organizational, political — as it is a technical challenge. Even where the organizational will exists to introduce and support LA, there remains the challenge of doing so in a way that involves stakeholders. If it is a commercial product, there may be limited scope for changing it, but how are requirements to be gathered, how much ownership do stakeholders feel they have, and how configurable is it? If the system is open source or developed in-house, there should be more scope for stakeholders to shape the design from an early stage, but how does an organization build its capacity to execute such a participatory design process and carry software prototypes through to produce a good user experience at scale? (See Buckingham Shum & McKay, 2018, for a discussion of two organizational strategies.)

2. Bringing Human-Computer Interaction to LA

These are not new challenges for people who wish to design successful interactive systems. There have been decades of work within subcommunities such as participatory design, user-centred design, and co-design. Every national computing society has its own dedicated communities focused on human-computer interaction and user experience (HCI/UX). The Association for Computing Machinery (ACM) special interest group on Computer-Human Interaction (SIGCHI: https://sigchi.org) is the association's second largest SIG, running conferences with around 4,000 delegates. The HCI community has a distinctive identity that has evolved over several decades (Grudin, 2017). During this time, it has developed from an assemblage of disciplinary sciences, shifted toward practical design practices, and worked hard to couple academic rigour with relevance in the fast-moving world of software design. While doing this, it has also developed its own conceptions of what theory means (Rogers, 2012) — moving from a naive assumption in the 1980s that human-centred disciplines such as cognitive psychology would provide sufficient conceptual and methodological tools to inform user interface design, toward much richer mixes of disciplines and methods.

The question of theory is of equal concern to the LA community, as we carve a dual identity as an academic discipline and an endeavour relevant to real design and educational practice. SoLAR's LAK conference has been run in cooperation with SIGCHI since 2012, and researchers are active in both the HCI and the LA fields. There is every reason in principle, therefore, to expect a deep intellectual synergy and a convergence of design practices. However, there remains a significant gulf between the two fields, which we argue is a critical challenge for LA.

Human-centredness can be defined at many levels, including user interface, impact on working practices, shifts in users' power and control, and ways in which values are built into the data models (Fitzpatrick, 2018). In all cases, human-centredness is a characteristic of systems that have been carefully designed by identifying the critical stakeholders, their relationships, and the contexts in which those systems will function. Creative processes or methodologies have then been used to generate an understanding of the stakeholders' needs, desires, and experiences (Giacomin, 2014).

The essence of adopting a human-centred approach is that the meanings, interaction opportunities, functions, and attributes associated with the system should be defined by the people for whom the system is intended, rather than imposed by designers or researchers. Design of LA should therefore take into account the range of people who will engage with them (who?), what all those people will do with them (what?), the various occasions on which these interactions will take place (when?), the ways in which the analytics will form part of interaction and discourse (how?), and the meanings that these analytics, interactions, and discourse will have for stakeholders (why?) (Giacomin, 2014). The HCI community has already produced widely used educational and training resources for undergraduate, postgraduate, and professional development in this area, on which the LA community could build (e.g., Sharp, Preece, & Rogers, 2019).

Of particular relevance to LA is the growing body of HCI work that engages with the specific challenges posed by interactive systems using artificial intelligence (AI) — particularly machine learning (ML). In fact, ergonomics, HCI, and the intelligent user interfaces communities have talked about designing "mixed-initiative systems" (a dated term that refers to combining human and machine agency) for more than two decades (e.g., Horvitz, 1999). We now see the emergence of human-

centred AI research centres[1] and UX for ML design communities (e.g., Holbrook, 2017; Kuniavsky, Churchill, & Steenson, 2017) and with AI user-interface guidelines (Amershi et al., 2019).

Building on decades of work in these various communities, in LA we must build on this body of knowledge and practice, adopting — and, where necessary, adapting — it in the educational contexts in which we work. In turn, LA should be feeding back to those communities to demonstrate what works, or fails, in educational contexts. It was for these reasons that the theme of the 2018 Learning Analytics and Knowledge conference (LAK '18) was *Towards User-Centred Design*, and it was at this conference that the first LAK Participatory Design workshop was convened (Prieto-Alvarez et al., 2018a). The variety of terminology used for closely related work (including user-centred design, participatory design, and human-centred design) reflects distinct identities in those fields, which is reflected in the LA community. We use the broad label of human-centred learning analytics (HCLA) to remain agnostic about the finer distinctions and to take into account the widest range of pertinent factors.

3. Overview of the Special Section Papers

Following on from the conference and workshop, this special section of the *Journal of Learning Analytics* gives further identity to HCLA, inviting not only new papers but also extended versions of some of the most promising LAK '18 papers in this area. We invited researchers and practitioners to submit theoretical, methodological, empirical, and technical contributions on topics including but not limited to the ones listed below:

- experiences deploying design processes that explicitly involve stakeholders (such as learners, educators, instructional designers, and leaders) in the co-design, co-creation, or participatory design of analytics tools;
- evaluations of tools and techniques that have been effective in assessing how end-users make sense of, interact with, and act on analytics feedback;
- examples of how LA systems can be made more transparent and accountable to different stakeholder groups;
- examples of how educational leaders can create the conditions for, or inadvertently undermine, HCLA systems;
- examples of the benefits (and costs) that the adoption of human-centred design tools and techniques can bring to stakeholders;
- arguments/conceptual models/examples clarifying *specific* challenges of human-centred design for LA, beyond those already well documented from other domains.

Of the 12 submissions received, four research papers and a practitioner paper completed peer review, providing an interesting, albeit incomplete, snapshot of what HCLA can look like in practice. Some of these papers address the above topics, while others introduce new ones. Table 1 summarizes the papers in this special section.

In "Working Together in Learning Analytics toward the Co-Creation of Value," Mollie Dollinger, Danny Liu, Natasha Arthars, & Jason Lodge (2019) provide an overview of participatory frameworks for LA, followed by a case study of how designers co-created LA platforms with teachers that have now been in use for six years by over 30,000 students — a scale of implementation that is relatively rare in the field. The paper distills implications for the use of participatory design frameworks in LA through a discussion of the costs, challenges, and benefits of adopting human-centred design.

In "Co-designing a Real-Time Classroom Orchestration Tool to Support Teacher-AI Complementarity," Kenneth Holstein, Bruce M. McLaren, & Vincent Aleven (2019) extend their LAK '18 Best Research Paper, arguing that the co-design of LA systems requires new methods to address the unique challenges of prototyping data-driven algorithmic systems. They exemplify such methods through a case study of the iterative co-design of augmented reality glasses for K–12 teachers. This work demonstrates how non-technical stakeholders can participate throughout the design process, from the earliest phases, through the selection and tuning of analytics, to evaluation in real-world contexts. The paper concludes with a summary of methodological recommendations for future co-design work in LA.

[1] See, for instance, human-centred AI institutes at Stanford (https://hai.stanford.edu) and MIT (https://hcai.mit.edu), with many other universities active at this intersection fostering collaborations between established HCI and AI centres.

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Table 1. Overview of Papers in This Special Section

Paper	Stakeholders	Methods
Working Together in Learning Analytics toward the Co-Creation of Value	LA researchers University educators Teaching support staff	Case study Semi-structured interviews Thematic coding Open coding
Co-designing a Real-Time Classroom Orchestration Tool to Support Teacher-AI Complementarity	LA researchers University educators	Methodology development, including • behavioural mapping • card sorting • directed storytelling • field observations • low/high-fidelity prototyping • replay enactment • semi-structured interviews • speed-dating sessions
Teaching with Analytics: Toward a Situated Model of Instructional Decision-Making	LA researchers University educators University IT staff	Inquiry into analytics use Semi-structured interviews User interface walkthrough Constant comparative method of inductive analysis
Designing in Context: Reaching beyond Usability in Learning Analytics Dashboard Design	LA researchers Middle-school teachers Data scientists User interface designers	Case study Participant observation Interviews Affinity mapping Think-aloud
Engaging Faculty in Learning Analytics: Agents of Institutional Culture Change	LA researchers University educators	Action research

In "Teaching with Analytics: Toward a Situated Model of Instructional Decision-Making," Alyssa Friend Wise & Yeonji Jung (2019) provide a detailed account of an inquiry into how educators engaged with a dashboard intended to help them understand student progress in order to improve their own practice and student outcomes. This exemplifies how a well-established form of analysis in HCI and information visualization — studying sense-making practices with and through visualizations — can be performed by LA designers and researchers to produce insights that can be transferred to other situations.

In "Designing in Context: Reaching beyond Usability in Learning Analytics Dashboard Design," June Ahn, Fabio Campos, Maria Hays, & Daniela Digiacomo (2019) make the case that HCLA should include, but go beyond, established ways of thinking about human-centred design in order to take into account wider work and the organizational context. This is not a new idea in HCI or participatory design, but there are few, if any, good case studies that exemplify how this plays out in the design of LA. The Research Practice Partnership/Improvement Science setting for this work provides exactly the right kinds of examples to show why, for instance, design decisions cannot be based solely on conventional interface design principles, divorced from the broader educational context.

Finally, in "Engaging Faculty in Learning Analytics: Agents of Institutional Culture Change," George Rehrey, Linda Shepard, Carol Hostetter, Amberly Reynolds, & Dennis Groth (2019) extend their LAK '18 practitioner paper. This has a different flavour from the preceding design case studies. Human-centredness in this case study takes the form of a carefully designed strategy to engage educators across a university with LA for the first time, building their capacity through a collegial Learning Analytics Fellows Program that supports action research. This program sought to directly address well-documented barriers to the use of LA, including culture management, adoption, and sustainability. The paper reflects on the strengths and

weaknesses of this strategy, analyzing self-reports of the program's impact and considering the broader impacts of this approach for the future.

4. Discussion

4.1. LA May Be 10 Years Old, but HCLA Is a Toddler

Reflecting on what we see in the papers in this special section, we can identify a spectrum of challenges to HCLA. None of these will be surprising to the HCI community, but together they underline how pervasive the challenges are across all sectors:

- Learning is a complex process that cannot be observed directly. It has cognitive, metacognitive, affective, and social aspects that are sensitive to context. The more we embrace this complexity, the more we become aware of the difficulties inherent in the creation of effective interfaces that communicate educational insights.
- Many current LA tools and dashboards require a level of digital literacy that has not yet been acquired by the majority of stakeholders. One way of dealing with this is to call for more training in this area. From a human-centred design perspective, though, it is more sensible to change the tools to suit their users, rather than changing the users to suit the tools. This perspective could shift the focus away from providing users with data to interpret, and toward providing them with answers to the questions they are asking. Drawing on the prescient insights of Engelbart (1963), there will be a co-evolution of human and machine capabilities, methodologies, and language.
- Non-experts are unlikely to be aware of the implications of different design choices, the potential of different analytic techniques, and constraints on implementation. New methods and combinations of methods, like those proposed by Holstein et al. (2019), are needed to involve them meaningfully within the design process.
- Involving stakeholders may be perceived as difficult, time-consuming, and expensive. Nevertheless, involving them throughout the design process can make the difference between an unsuccessful prototype and a system that is taken up successfully.
- In terms of the ethics of LA and growing concerns about the misuse of data, human-centred design has the potential to shift LA from something done to learners toward something done with learners. This ethical perspective is one that could be more widely taken up and highlighted.

We are struck by the fact that all of the papers in this special section describe systems that target *educator*s as end-users. The absence of a paper documenting *learner* involvement in the design process underlines how far LA needs to catch up with design practices that are now widely used in other fields. These papers, of course, provide only a partial snapshot. Examples of student engagement in LA design processes do exist, but they are currently exceptions to the rule (e.g., Chen & Zhu, 2019; Prieto-Alvarez, Martinez-Maldonado, & Shum, 2018b). We anticipate that future snapshots will demonstrate how the field is maturing in this regard.

The LA community's interest in dashboards reflects an implicit concern with getting the learner experience right. Nevertheless, few projects engage seriously in this process. In this regard, LA resembles many other fields. Researchers and designers recognize the value of human-centred design when they see it used to produce outstanding everyday products — we all know what it feels like when "everything just works." However, over the last decade, much more attention has been paid to the underlying analytics and AI, rather than to the design process. The field cannot afford to neglect human-centred design if it is serious about developing tools that will be taken up widely by both educators and learners.

What is likely to happen is that it will be companies, rather than research institutions on meagre grants, that invest in UX design and produce a smooth product experience. However, it is research institutions that are best placed to develop a deep understanding of the needs of educators and learners, as well as the pedagogies that underpin analytic tools. Academia and commerce both have something to offer the other. We therefore challenge our academic colleagues to partner with their HCI colleagues and seek to break new ground in HCLA, demonstrating the value of deep analysis of user needs and deep stakeholder engagement. Academia always finds open-source projects attractive, and consortia around such platforms may yet demonstrate that they can deliver on the UX as well — after all, we teach UX to our students.

Beyond the narrow confines of the user interface, LA researchers are also interested in the wider *sociotechnical systems* in which tools must be embedded for sustainable impact. These systems include pedagogy, stakeholders, communities, current practices, context, technical components, and business models. Innovations that do not take into account all aspects of the system are unlikely to be successful in the long term. This has led to calls for the adoption of complex systems perspectives (e.g., Crick, 2017; Dawson et al., 2018; Ferguson et al., 2015; Siemens & Baker, 2012). The emergence of critical studies of

data, algorithms, and infrastructure is also translating into critical perspectives on LA as infrastructure that embodies values, politics, and worldviews (Buckingham Shum, 2018; Buckingham Shum & Luckin, 2019, in press; Selwyn, 2019, in press). This theoretical and practical interest in how analytics both depend on, and in turn shape, sociotechnical infrastructures is an important differentiator between LA and sister communities such as educational data mining and AI in education, which scope systems more narrowly in terms of learners, interaction with software tools, and learning outcomes.

4.2. What Is an HCLA Contribution?

How should the LA community judge the quality of HCLA research papers? A valid *research* methodology for HCLA, which will help develop a rigorous academic literature, is not the same as a *design* methodology that strives for principled but pragmatic tools that can survive the pressures of the software design process. This tension reflects the ongoing discussion in the community about the balance of academic research and practitioner reports that are represented in this journal and at the LAK conferences.

Table 1 (above) briefly outlines the methods and methodologies used in the papers in this special section. It is notable that most of this work is based on qualitative data. In addition, these papers do not take the positivist stance associated with much quantitative work. Instead, they acknowledge that understandings of reality vary in different contexts. There is a shift here away from the primarily quantitative focus of LA toward rich accounts that help to uncover why and how analytics are used, and why they may be misused or ignored.

The HCI community has had extended debates about the different genres of paper that are required to recognize the diversity of contributions it values, and the criteria that are used to judge them. These debates have produced detailed guidelines that are used to induct newcomers.[2] The LAK community might adopt or adapt this work in order to both clarify what counts as an HCLA contribution and promote high-quality work. Building on Wobbrock & Kientz (2016, pp. 40–42), we see no reason not to encourage all seven of the contribution types they identify, prefixing these with "HCLA" (see the paper for fuller descriptions and examples of such papers):

- **HCLA empirical research contributions:** "new knowledge through findings based on observation and data gathering."
- **HCLA artifact contributions:** "HCI is driven by the creation and realization of interactive artifacts. Whereas empirical contributions arise from descriptive discovery-driven activities (science), artifact contributions arise from generative design-driven activities (invention)."
- **HCLA methodological research contributions** "create new knowledge that informs how we carry out our work. Such contributions may improve research or practice."
- **HCLA theoretical research contributions** "consist of new or improved concepts, definitions, models, principles, or frameworks."
- **HCLA dataset contributions** "provide a new and useful corpus, often accompanied by an analysis of its characteristics, for the benefit of the research community."
- **HCLA literature survey research contributions** "…and other meta-analyses review and synthesize work done on a research topic with the goal of exposing trends and gaps."
- **HCLA opinion research contributions,** "…also called essays or arguments, seek to change the minds of readers through persuasion."

These categories could be used to inform the criteria for LAK conferences, for workshops, and for this journal. However, HCI ≠ HCLA, as has been argued convincingly in the context of learning dashboards (Jivet, Scheffel, Drachsler, & Specht, 2018; Matcha, Gasevic, & Pardo, 2019; Teasley, 2017). Thus, we would surely want to ask of any LA paper, "What are the implications for teaching and learning, and for the environments in which these take place?" This question might be answered differently according to the genre of paper and the nature of the contribution.

4.3. What Makes HCLA Different from Other Domains?

At this point, one might be forgiven for concluding that LA is no more than another important context in which HCI methods can be fruitfully applied. Viewed from this perspective, the value of the papers in this special section is to demonstrate that

[2] See, for instance, the discussion of different kinds of research contributions in HCI by Wobbrock & Kientz (2016), as well as the guide to writing a successful CHI paper (CHI, 2019).

HCI methods are just as relevant in LA as they are elsewhere, providing detailed accounts of how this plays out in educational institutions. However, we propose that this view is limited, implying that there is nothing about *educational institutions* that distinguishes them from other organizations, and nothing distinctive about *learning* and *learners*, compared to the myriad other forms of activity and users for which HCI designs.

We propose that this assumption can and should be challenged in future work. Consider one important point where this assumption does not hold. In most HCI design contexts, stakeholders are treated as authoritative sources on how their work should be performed. Current work practices are studied to ensure that the envisaged software system does not inadvertently disrupt the human ecology of formal and informal activity. In sharp contrast, for HCLA, while learners are obviously able to speak with authority about their experiences of studying, they are

- not expert learners whose work practices should necessarily be worked around;
- not experts in the subject matter;
- not expert educators whose views — e.g., about the design of a course, what counts as good feedback, or what analytics will help learning — can be treated as authoritative.

What are the implications for adopting and adapting human-centred design methods, when learners have such a partial understanding of the activities in which we want to support them?

5. Conclusion

All sectors of society are wrestling with the challenge of designing interactive software tools that are intuitive, effective, and, ideally, delightful to use. This is not a new problem, and educational technology — LA specifically — is no exception. We hope this special section leaves you with an expanded vision, specific ideas, and better questions regarding how your LA tools and infrastructures could become more human centred. In this editorial, we have identified significant gaps in the field and pointed to the kinds of contributions that will advance the field, so that the LA community can build on — rather than reinvent — the decades of work in human-centred software design. Ultimately, this is about making a deeper, wider impact, more quickly, with tools that are fit for purpose and a pleasure to use.

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